Air Resources Laboratory

Climate Variability and Change Analysis

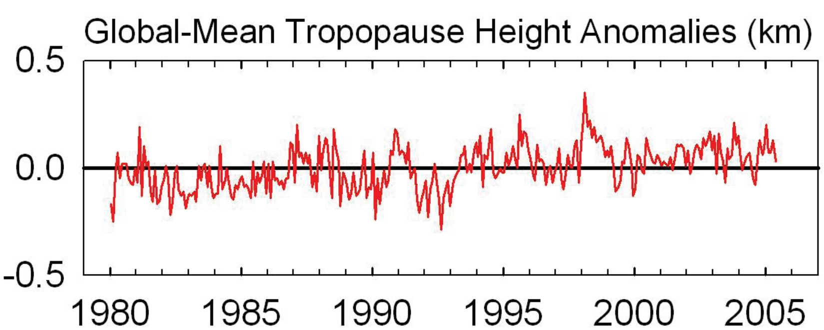
Collaborating with colleagues around the world to enhance the scope and quality of climate science

The Air Resources Laboratory (ARL) provides essential information and tools for decision-makers to understand how and why climate has changed and what changes might occur in the future. This information aids in understanding the nature of the climate system and is used by scientists around the world to evaluate climate models. One component of ARL's Climate Research is Climate Variability and Change Analysis. This research was initiated in the 1970s and is one of the longest-running observational climate research activities in NOAA. National and international climate scientists and decision-makers use ARL's analyses to understand climate trends and the need for mitigating and adapting to climate change. ARL climate scientists have contributed to a number of climate change assessments, including the work of the Intergovernmental Panel on Climate Change, the U.S. Global Change Research Program, the World Climate Research Programme, the World Meteorological Organization, and the United Nations Environment Programme.

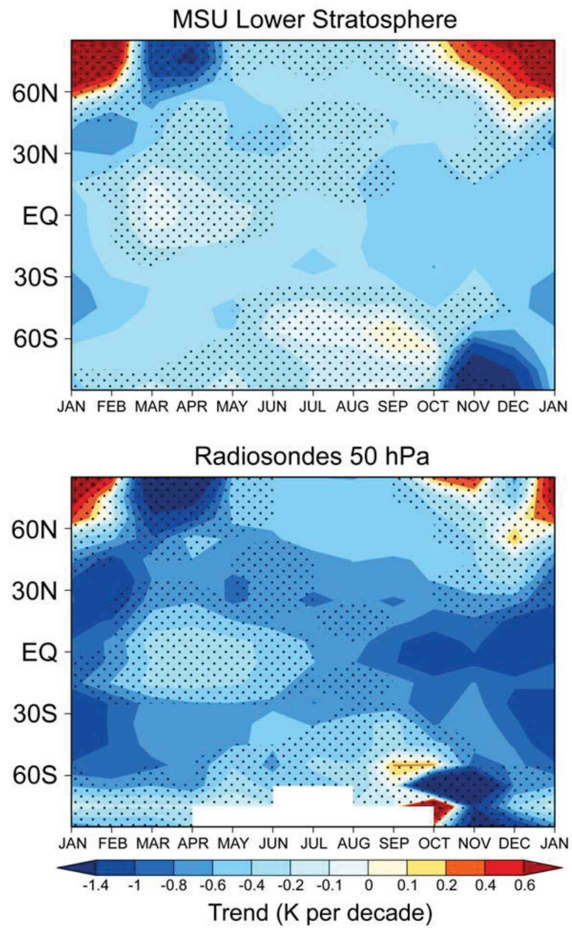
What We Do

ARL's Climate Variability and Change Analysis research involves study of daily to multi-decadal atmospheric variations measured by many types of climate observation systems. One challenge is incorporating archived historical weather observations that were not originally designed or conducted with climate change research in mind. Consequently, significant effort is directed toward understanding the observations and identifying any artificial signals that might mask or imitate true signals of climate variability.

While climate data come from many sources, ARL scientists are internationally recognized leaders in analyzing radiosonde data—air temperature, humidity, and wind data collected by a balloon-borne instrument with radio transmitting capabilities. ARL's radiosonde research has led to methods for identifying data problems and producing new, improved datasets that remove artificial, non-physical signals from climate observations.



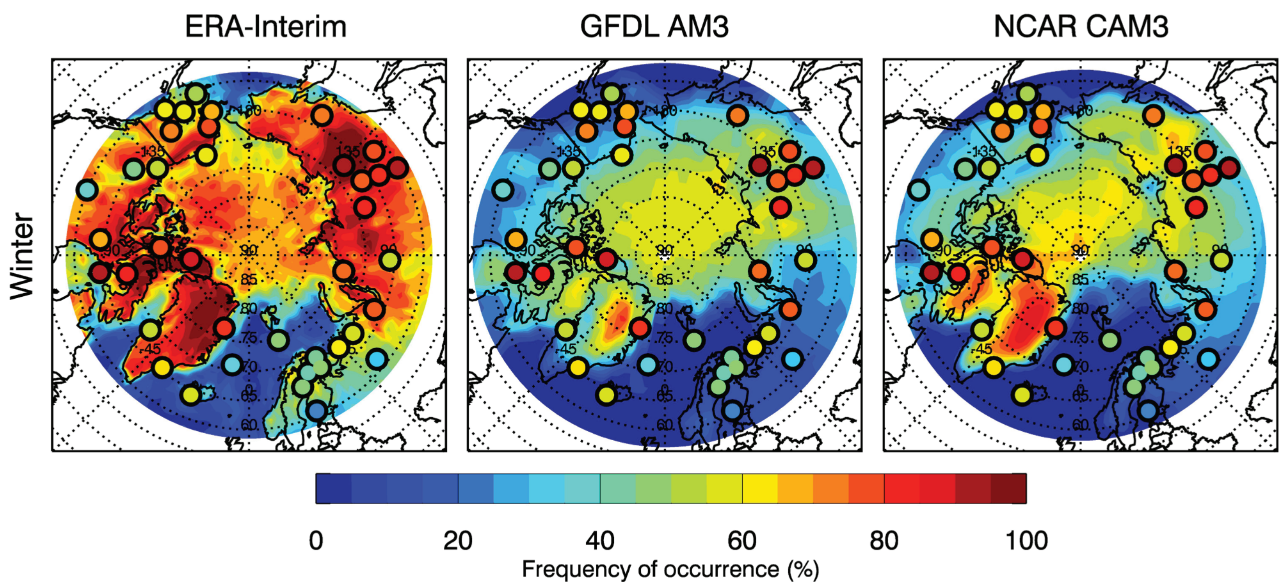
Changes in the height of the tropopause are related to other changes in the climate system. Radiosonde data show an increase of about 160 meter increase over 25 years in the global-average height of the tropopause. Seidel and Randel (Journal of Geophysical Research, 2006)



The seasonal and latitudinal structure of lower-stratospheric temperature change (Kelvin per decade) may reveal clues to the causes of the changes. Satellite (top) and radiosonde (bottom) observations show cooling (blue) of the tropics and wintertime warming (red) of the polar regions over 1979-2010. Seidel et al. (Wiley Interdisciplinary Reviews: Climate Change, 2011), Free (Journal of Climate, 2011)

These new datasets allow more confident estimations of climate trends and more complete characterization of the uncertainty of those estimates. Through collaboration with climate modeling groups, ARL datasets are used to evaluate global climate models. ARL data products—such as global and national upper-air temperature and humidity, heat waves, ozone concentrations, cloudiness, and special features including the planetary boundary layer (the air layer closest to and most influenced by the ground) and the tropopause (the boundary between the troposphere and the stratosphere)—are made publicly available to the scientific community and others through various data centers, most notably NOAA's National Climatic Data Center.

Climate change research involves identifying trends that cannot be explained by known sources of natural climate variability, or by observational uncertainty. Identifying corroborating evidence for a given climate trend helps to increase confidence of a detected signal.



The boundary layer in the Arctic region controls important climate processes, including heat and moisture fluxes, cloud formation, and pollutants. Surface based inversions inhibit boundary layer mixing and occur frequently in the Arctic, but climate models do not capture all aspects of their climatology. Climatological analysis of the frequency of occurrence (in percent) of Arctic surface-based inversions in 20 years of radiosonde observations (circles on maps) and a reanalysis dataset (left panel) indicates more frequent inversion formation than is simulated in the two climate models (center and right panels). Zhang et al. (Journal of Climate, 2011)

ARL Climate Research and Development
www.arl.noaa.gov/climate.php
Radiosonde Atmospheric Temperature Products
www.ncdc.noaa.gov/oa/climate/ratpac/index.php
U.S. Heat Stress Index Data
www.ncdc.noaa.gov/oa/climate/research/heatstress/
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